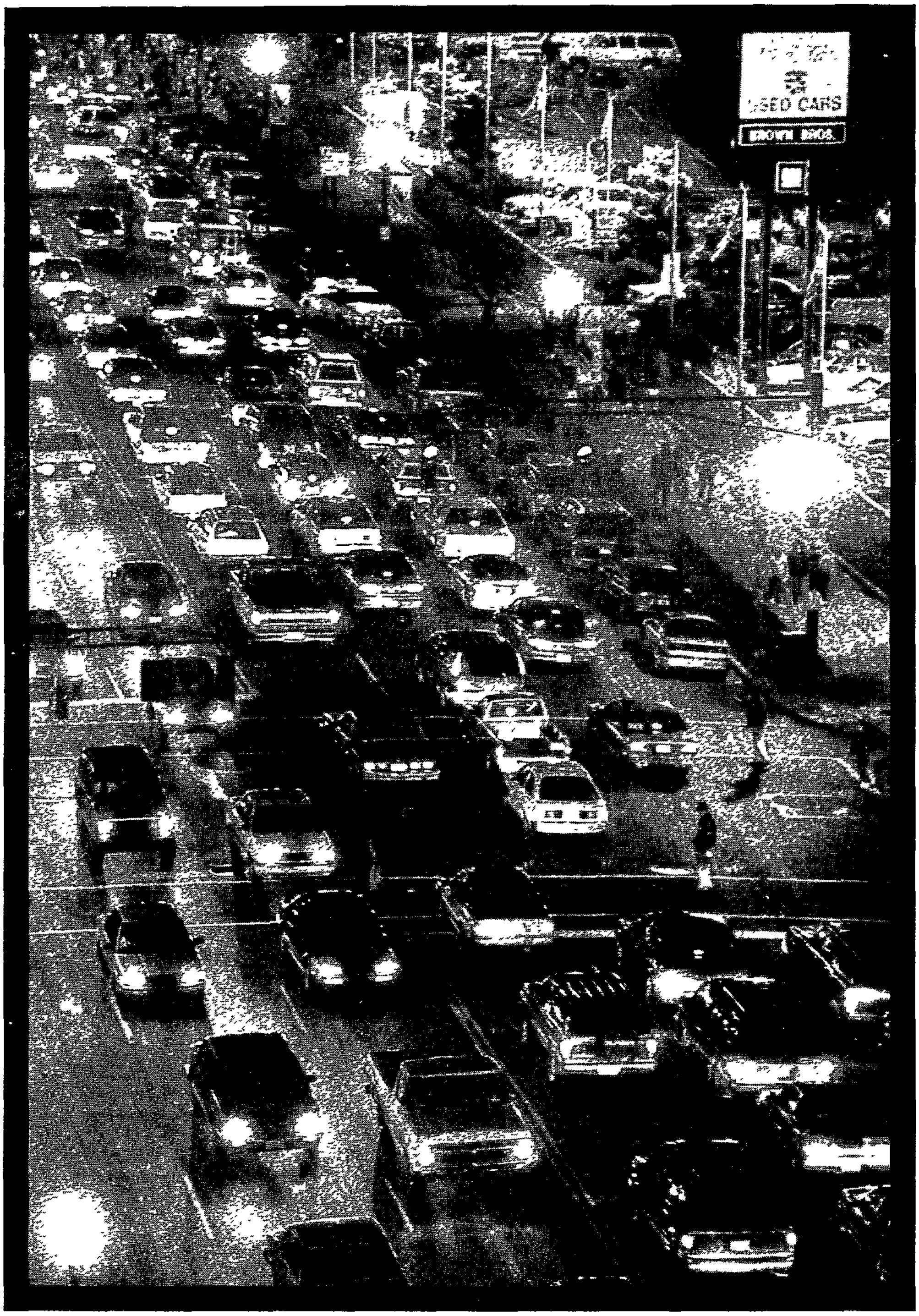
5. RECOMMENDATIONS



Source: The Courier-Journal

April 18, 1994

Traffic leaving Thunder Over Louisville causes congestion for hours on local streets and highways.

5. RECOMMENDATIONS

Information provided in the previous four chapters provides a foundation for selection of recommended incident management actions for the Metropolitan Louisville area. Chapter 1 identified goals and objectives to be achieved by the system. Chapter 2 provided data regarding the facility and its operations. Chapter 3 summarized input from incident response personnel and related it to incident management functions. Chapter 4 described incident management options. A combination of this information was used to develop recommendations presented in this chapter.

5.1 Proposed Plan

Three stages of implementation are recommended for the development of an Incident Management System for the I-65 corridor. These stages are Early Action, Initial System, and Full System.

The Early Action plan is formulated to provide early benefits and rapid implementation at minimal cost. It is also intended to provide an effective foundation for further incident management system development. The Initial System will provide improved surveillance and communications capabilities through establishment of a traffic operations center and installation of the first electronic systems within the corridor. As proposed, the Initial System would serve approximately seven miles of the I-65 corridor. The Full System will extend electronic surveillance and motorist communications to the entire study area and will provide a dedicated fiber optics communication network to link system components.

The recommended elements of the Early Action, Initial System, and Full System plans are listed in Table 5-l and summarized in this chapter. Using an evaluation matrix format, Table 5-2 relates potential improvement options with the project objectives identified in Chapter 1. In addition to objectives achievement, system recommendations are based on input from incident response personnel and from the Incident Management Task Force.

The recommendations presented here are sufficient to serve their intended purpose of establishing feasibility and identifying potential benefits, and guiding the next step of project development. Since incident management system technology is evolving rapidly, specific equipment is not specified at this stage. Instead, the system is defined in a conceptual manner which will provide flexibility as the system is implemented. More detailed information on current technology and communications has been included in the appendices.

By design, the Early Action plan is a low cost approach to incident management. Several recommendations relate to improved communication and coordination among agencies. Implementation should begin with the completion of this report. It would be reasonable to implement the Initial Freeway Incident Management System over a two to five year period, with Full System development occurring incrementally over time.

Subsequent sections provide more detailed descriptions of actions and components recommended for each phase of system development. The format is the same as that used in the previous chapter, with recommendations described in the categories of: incident detection/verification, response time, site management, clearance time, and motorist information.

Table 5.1 Recommended Improvement Options

	Potential Improvement Options	Recommended Implementation Stage Early Action Year 1	 Initial System Year 2-5	 Full System Year 5+
1	Dedicated Freeway/Service Patrols	X	X	X
3	Incident Reporting with Cellular Telephones	X	X	X
4	Citizens' Band (CB) Radio Monitoring		?	?
6	Ties with Transit/Taxi Companies		?	X
7	Aircraft Patrols (Commercial Media)	X	X	X
8	Electronic Detection		X	X
9	Closed Circuit Television Cameras		X	X
10	Traffic Operations Center		X	X
11	Personnel, Equipment, and Materials Resource Lists	X	X	X
12	Personnel Training Programs	X	X	X
13	Tow Truck/Removal Crane Contracts	X	X	X
14	Improved Interagency Radio Communication	X	X	X
15	Ordinance Governing Travel on Shoulders	X	X	X
17	Diversion Route Planning	X	X	X
18	Equipment Storage Sites	X	X	X
19	Administrative Traffic Management Teams	X	X	X
20	Public Education Program	X	X	X
21	Closely Spaced Reference Markers	X	X	X
22	Incident Response Teams	X	X	X
23	Properly Defined Traffic Control Techniques	X	X	X
24	Parking for Emergency Response Vehicles	X	X	X
26	Incident Response Manual	X	X	X
27	Policy Requiring Fast Removal of Vehicles	X	X	X
28	Accident Investigation Sites		?	?
29	Push Bumpers	X	X	X
30	Responsive Traffic Control Systems		X	X
31	Total Station Accident Investigation Equipment	X	X	X
32	Highway Advisory Radio	X	X	X
33	Variable Message Signs	X	X	X
34	Commercial Radio and Television Broadcasts	X	X	X
35	Kiosks		?	?
36	PC/Modem			?

? - Indicates future options/action steps subject to further review.

Table 5.2
Evaluation Matrix

	Potential Improvement Options	Freeway Incident Management System Objectives						
		Improve Air Quality	Reduce Fuel Consumption	Reduce User Delay	Increase Existing Capacity	Improve Travel Safety	Improve Operators Cooperation	Improve Communication with Public
1	Dedicated Freeway/Service Patrols	X	X	X		X		X
3	Incident Reporting with Cellular Telephones		X	X		X		X
4	Citizens' Band (CB) Radio Monitoring		X	X		X		X
6	Ties with Transit/Taxi Companies	X	X	X				
7	Aircraft Patrols (Commercial Media)	X	X	X		X		X
8	Electronic Detection	X	X	X				
9	Closed Circuit Television Cameras	X	X	X		X	X	
10	Traffic Operations Center	X	X	X	X	X	X	X
11	Personnel, Equipment, and Materials Resource Lists			X		X	X	
12	Personnel Training Programs			X		X	X	
13	Tow Truck/Removal Crane Contracts	X	X	X		X		
14	Improved Interagency Radio Communication					X	X	
15	Ordinance Governing Travel on Shoulders	X	X	X		X		
17	Diversion Route Planning	X	X	X				
18	Equipment Storage Sites					X	X	
19	Administrative Traffic Management Teams					X	X	
20	Public Education Program					X		X

Table 5.2
Evaluation Matrix (continued)

	Potential Improvement Options	Freeway Incident Management System Objectives						
		Improve Air Quality	Reduce Fuel Consumption	Reduce User Delay	Increase Existing Capacity	Improve Travel Safety	Improve Operators Cooperation	Improve Communication with Public
21	Closely Spaced Reference Markers	X	X	X			X	
22	Incident Response Teams	X	X	X		X	X	
23	Properly Defined Traffic Control Techniques	X	X	X	X	X		
24	Parking for Emergency Response Vehicles	X	X	X		X	X	
25	Flashing Lights Policy			X	X	X		
26	Incident Response Manual	X	X	X		X	X	X
27	Policy Requiring Fast Removal of Vehicles			X	X	X		
28	Accident Investigation Sites	X	X	X	X	X		
29	Push Bumpers	X	X	X		X		
30	Responsive Traffic Control Systems	X	X	X	X			
31	*Total Station Accident Investigation Equipment*	X	X	X		X		
32	Highway Advisory Radio	X	X	X		X		X
33	Variable Message Signs	X	X	X		X		X
34	Commercial Radio and Television Broadcasts	X	X	X		X		X
35	Kiosks							X
36	PC/Modem	X	X	X				X

5.2 Early Action Recommendations

Ease of implementation and high benefits are key considerations in identifying components of the Early Action system. Several of the improvement options lend themselves to immediate implementation and would provide effective building blocks for incident management system development. Each recommended component or action of the Early Action plan is discussed in the following paragraphs.

<u>Incident Detection/Verification Options</u>

Dedicated Freeway/Service Patrols should be initiated as an early step in system development. They are effective in aiding motorists and detecting incidents. A patrol vehicle would cover the area several times during the peak periods. This vehicle would clear small incidents such as vehicles with flat tires, over-heated radiators, or empty fuel tanks. Use of a private van service operation is recommended as an effective public/private option if an appropriate sponsor can be identified. Incident Management Task Force members have already made some initial inquiries to locate potential sponsors.

Another means of detection with low cost and high benefit is the use of **Incident Reporting with Cellular Telephone** calls to report emergencies to a central location. It is important for the operator of the cellular telephone line to be able to screen calls that are not of an urgent nature. The operator needs to know if vehicles are blocking the travel lanes or if there appear to be injuries or fires. Roadside signs and media releases should emphasize the use of this system for emergencies only.

<u>Response Time Improvement Options</u>

Through direct assistance and better recognition of needs at the scene, **Dedicated Freeway/Service Patrols** will provide for more timely and appropriate response for many minor incidents. Service patrols are somewhat unique in combining the functions of incident recognition and response.

Several institutional actions that would improve response times should be implemented relatively easily by an active Incident Management Task Force. An early activity of the Task Force would be development of **Personnel, Equipment, and Materials Resource Lists.** This group would also lead the development of **Administrative Traffic Management Teams** and associated **Personnel Training Programs.**

Consideration should be given at this stage to developing **an Ordinance Governing Travel on Shoulders.** This would provide better access for emergency vehicles but may be possible only in areas of the I-65 freeway where the shoulder widths are wide enough for emergency equipment.

Improved Agency Communications is a particularly important element of any incident management plan. There are several mechanisms for accomplishing improved communications, such as telephone lines, dedicated circuits, commercial pager, fax, radio and data modem.

Tow Truck/Removal Crane contracts should be revised to place greater emphasis on rapid response. Both the Louisville Division of Police and the Indiana State Police rely, at least in part, on private towing companies to assist in the clearance of major freeway incidents. Prepositioning of tow trucks during peak hours, special events, or construction periods should also be considered. The Kennedy and Watterson interchanges are locations which might benefit from the nearby positioning of tow trucks.

The only mention of response time in the existing Louisville towing contract is a requirement that the company notify the dispatcher if response time will be greater than 30 minutes. Incorporating language to improve response time is among the most important elements of the Early Action Plan. Performance of towing companies should be reviewed annually to determine whether requirements for timely response are being met. Furthermore, consideration should be given to adding incentives to encourage rapid clearance by towing services.

Diversion **Route Planning** should be considered part of an overall program to coordinate and preplan incident agency responses. **Public Education** Programs should be implemented to raise the consciousness of the public regarding the incident management actions.

A tool to reduce response time is **Closely Spaced Reference Markers** and landmark signing. It is very important to determine the direction and location by mile/kilometer post or by landmark and relay that information to the proper response agency. Jurisdictional boundary signs are also important in locating incidents.

<u>Site Management Options</u>

Incident Response Teams and **Administrative Traffic Management Teams** are inexpensive to formulate and provide significant benefits for site management. **Personnel Training** Programs also help to improve coordination at the incident site. The incident management team can contribute significantly to improved site management by establishing **Improved Interagency Radio Communications** procedures and **Properly Defined Traffic Control Techniques.**

Alternative Route Planning is another important activity of the incident management team. In addition to benefitting motorists, effective diversion of uninvolved traffic would improve the management of major incident sites.

<u>Clearance Time Reduction Options</u>

Institutional actions included in the Early Action plan are development of **Incident Response Teams and Administrative Traffic Management Teams,** along with their corresponding **Personnel Training Programs.**

Development of a **Policy Requiring Fast Removal of Vehicles** is a low cost method of returning the roadway to normal operating conditions where shoulders exist or there is adequate space for a holding area. Once again, many minor incidents can be cleared by means of **Dedicated Freeway/Service Patrols** and by vehicles equipped with **Push Bumpers,** eliminating the time for notification and response of tow truck vehicles.

Another option which would contribute to reduced clearance time is **Total Station Accident Investigation Equipment.** This electronic equipment measures distances quickly and accurately, reducing the time necessary for accident investigations. For fatal accidents, which typically require the closure of the entire freeway, this would provide a significant benefit.

<u>Traveler/Motorist Information Options</u>

Highway Advisory Radio is effective in informing a large number of motorists of roadway conditions at minimal cost. Use of HAR in the Metropolitan Louisville area will need to be coordinated with Disaster and Emergency Services and the Louisville Tourist and Information Bureau since they presently control the 1610 AM and 530 AM bandwidths, respectively. Another alternative would be requesting a new frequency from the FCC. It is anticipated that the two locations recommended will operate separately.

Variable Message Signs should be considered for early installation at key entry points to the Metropolitan Louisville area freeway system. These should be supplemented **by** portable variable message signs during major incidents, special events, or periods of construction.

Commercial Radio and Television Broadcasts are already relied upon by large numbers of people for a wide range of information, including traffic conditions. The incident management team should coordinate with public media and identify effective means of using this media to inform the traveling public.

5.3 Initial System Recommendations

The Initial System covers approximately seven miles of I-65, and utilizes leased telephone lines and microwave video equipment for communications. This Initial System provides coverage for the main portion of I-65 through downtown Louisville and the approach from Indiana.

Figure 5.1 shows the recommended system architecture for the Initial System, while Figures 5.2a and 5.2b show the recommended layout. To expand and complement the actions and elements recommended for the Early Action Plan, the improvement items discussed in this section are recommended for inclusion in the Initial System.

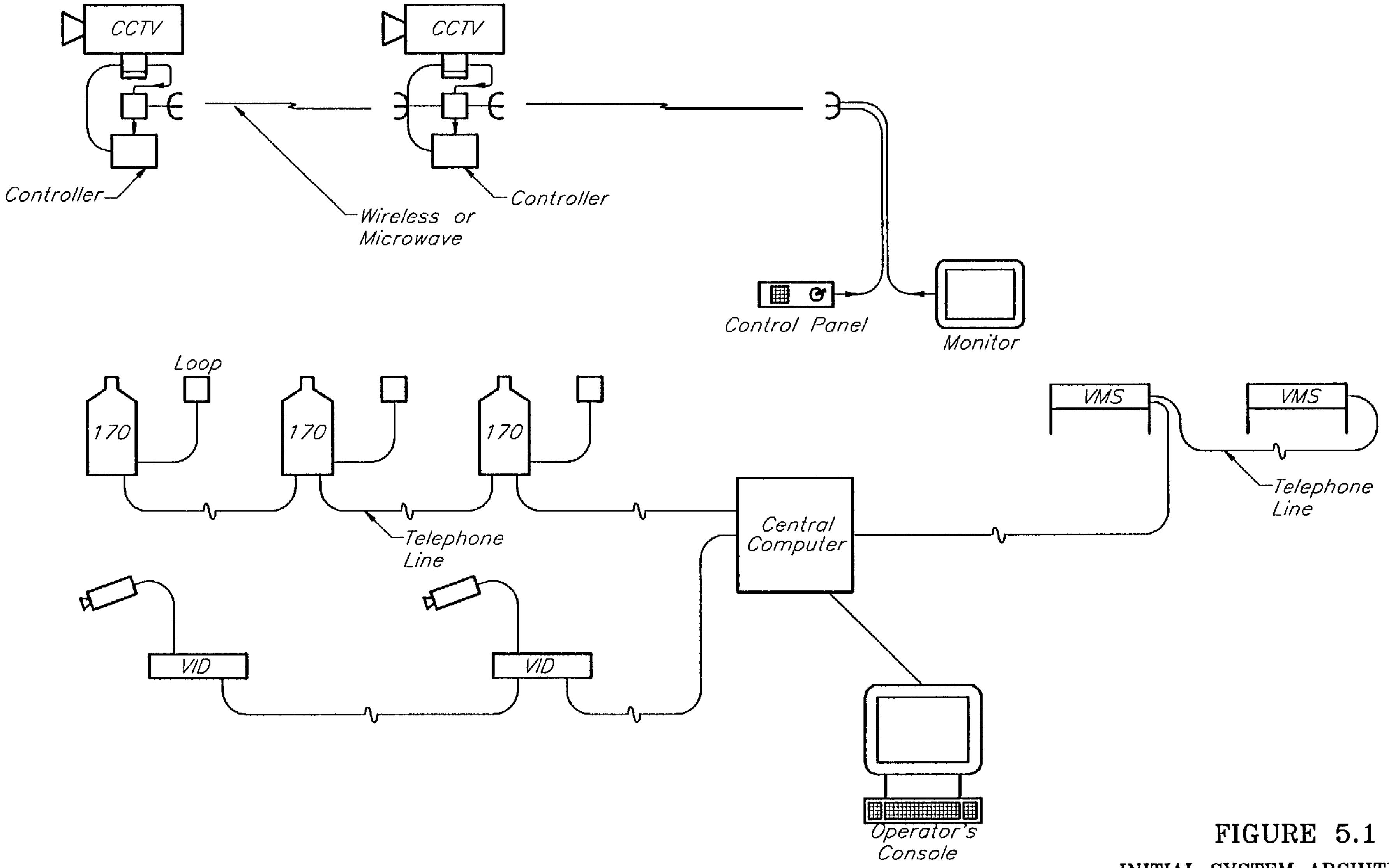
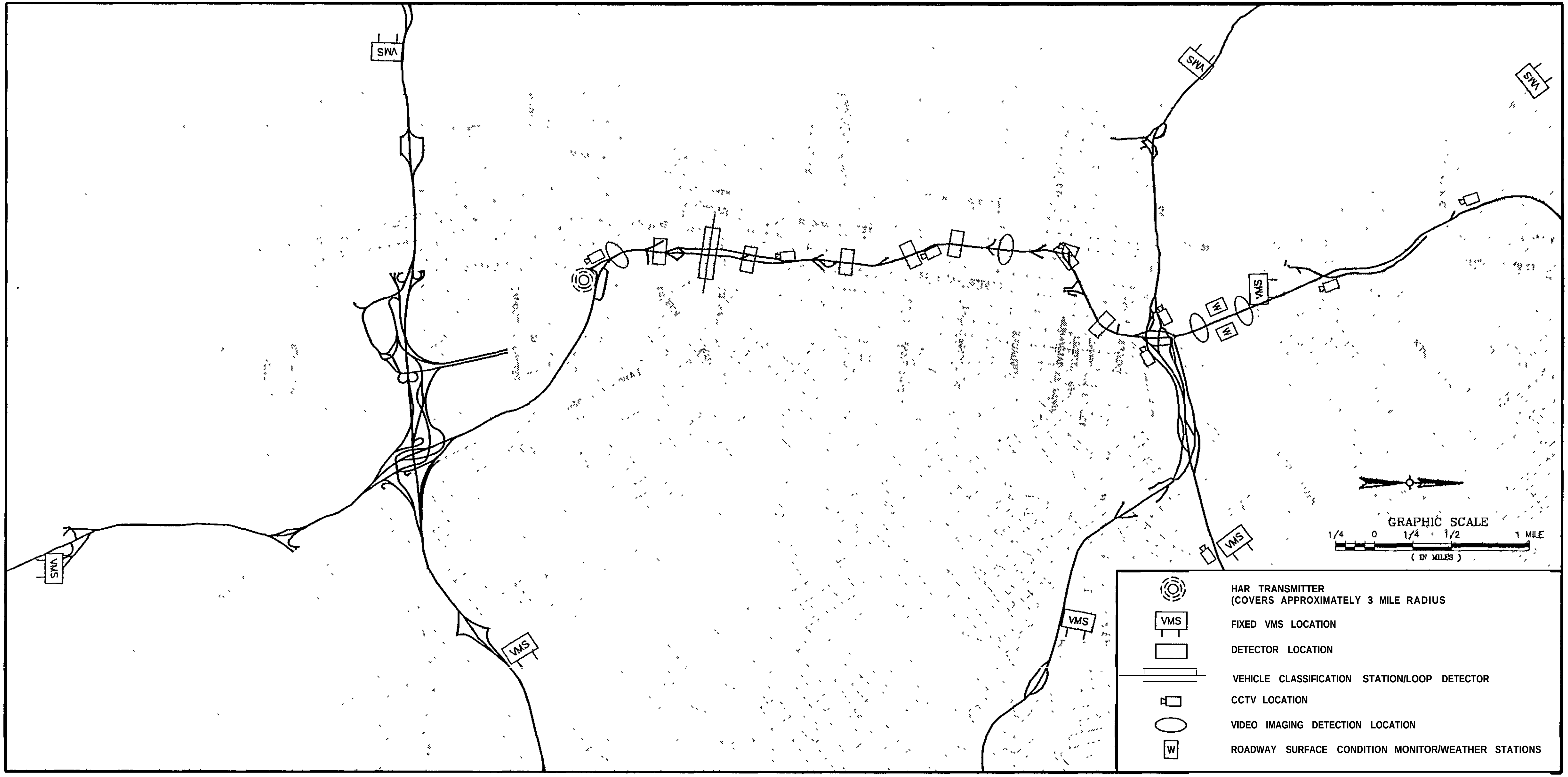


FIGURE 5.1
INITIAL SYSTEM ARCHITECTURE

HNTB in association with
PRESNELL ASSOCIATES INC.
I-65 Freeway Incident Management Study



ADDITIONAL VMS LOCATIONS

I-71 WB, 3/4 mile east of 1-264/I-71 interchange
I-64 WB, 3/4 mile east of I-264 interchange
I-264 WB(Inner Loop), 3/4 mile east of I-64 interchange

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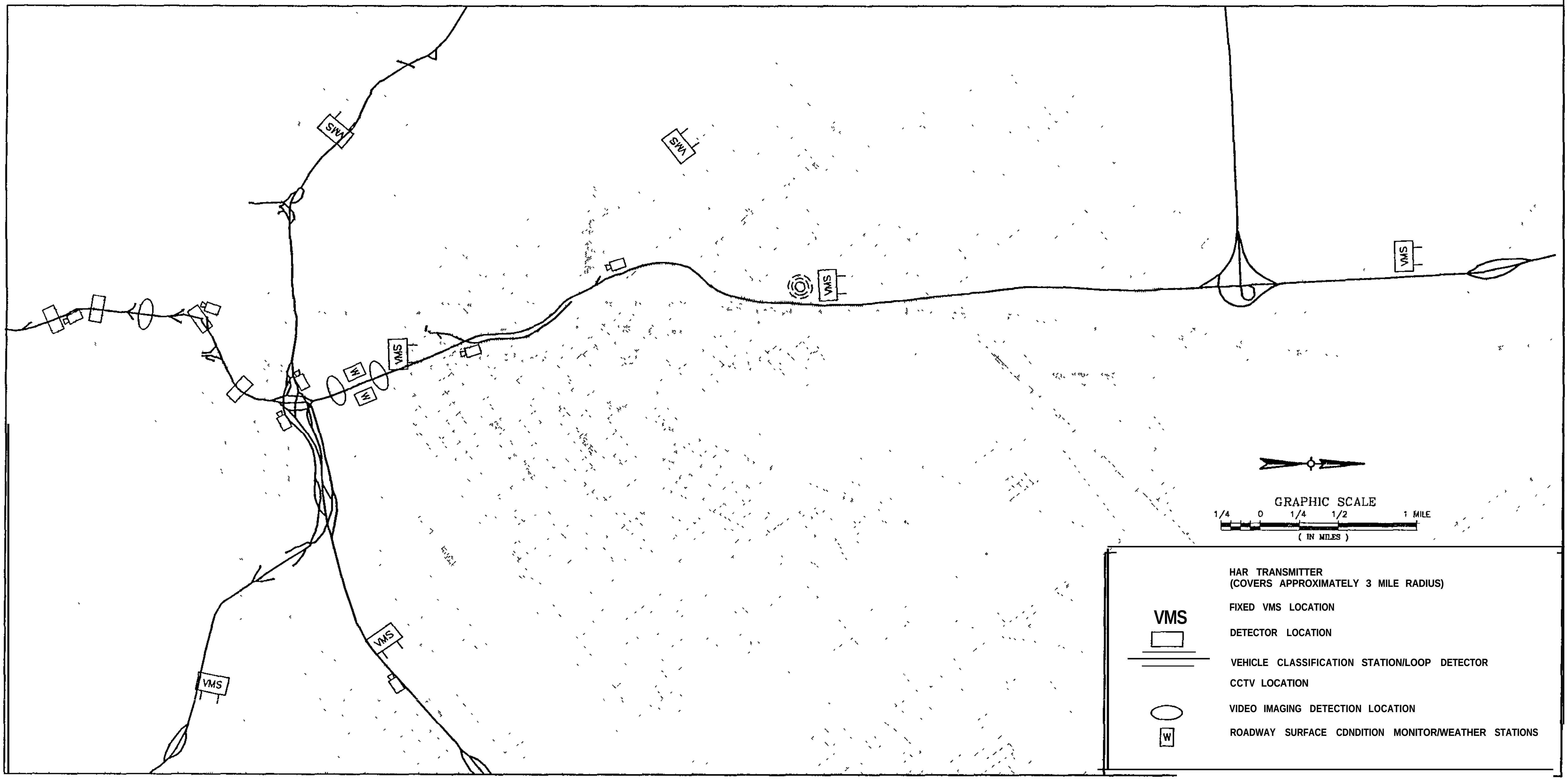
I-65 Freeway Incident Management Study

FIGURE 5.2a

INITIAL SYSTEM



ADDITIONAL VMS LOCATIONS

I-71 WB, 3/4 mile east of I-264/I-71 interchange
I-64 WB, 3/4 mile east of I-264 interchange
I-264 WB(Inner Loop), 3/4 mile east of I-64 interchange

FIGURE 5.2b

INITIAL SYSTEM

Incident Detection and Verification Ootions

Electronic Detection systems such as inductance loops, radar detection units, and video imaging detection systems (VIDS) are recommended to assist in incident identification. Existing loops will be used, where properly located. Identification of specific detection equipment will be reevaluated at the design stage in order to ensure that technologies are current and properly integrated at the time of implementation.

In general, the spacing of vehicie detectors along the freeway is about one half mile. In the downtown Louisville (where the on/off ramps are less than one half mile apart), the detectors will be located at each on/off ramp location. In Indiana, the newly configured slip ramps to/from the service roads will be reflected in the placement of vehicle detectors, with the goal of monitoring all access and egress for I-65.

Based on current technology, a mix of induction loops and VIDS is recommended. Induction loops are a stable, economical, and proven technology, and they are used wherever possible. In areas where structures or bridges make loop installation difficult, VIDS is recommended. VIDS has moved from field trials to moderate size system use in the past year. The technology will continue to be enhanced for many years, but it is adequately stable and proven for deployment on I-65.

Specific equipment locations typically have to be finalized in the field, to take advantage of crash protection for cabinets, pull-off sites for maintenance vehicles, ease of access for power, line-of-sight between loops and the control cabinet, and related factors to optimize each individual location.

Closed-Circuit Television Cameras are recommended for purposes of incident verification. For the seven-mile Initial System, approximately eight cameras will be required to provide appropriate coverage.

Closed circuit television cameras are located approximately one mile apart, at turns in the freeway, and at major interchanges. Where possible, mounting of cameras on buildings within the downtown Louisville area will be used to improve camera height and thus increase the area covered. Various camera pole heights, ranging from 30 feet to in excess of 100 feet, are in use by different agencies. Detailed site investigations, including field-of-view considerations, are required to finalize specific locations. The same considerations noted for vehicle detectors are of importance for CCTV cameras.

Weather Monitoring Equipment is recommended for placement on the Kennedy Bridge. This equipment provides detailed information that is beneficial in managing responses to weather conditions that create traffic disruptions. Operational experiences reported by other agencies show that this equipment is rapidly paid for by savings in Iabor and chemicals used for ice and snow clearance.

The collected information will be processed at a **Traffic Operations Center.** This center will begin operations with a small staff, probably in an existing facility. Special environmental conditions are unnecessary since modem systems use computers similar to those of most offices. As the system evolves, additional staff and facilities will be added to meet expanded needs. Ultimately, communications requirements and proximity to related agency personnel will determine the best site and/or facility for the Traffic Operations Center.

Monitoring of **Citizens Band (CB) Radio** will be advisable within the traffic operations center. This function will be performed in addition to providing for cellular calls and coordinating with service patrols and incident responders.

Response Time Tmurovement Options

As a result of reduced incident detection time and better communications, response time will be improved by the development of an effective **Traffic Operations Center.**

If space is available, **Equipment Storage Sites** would reduce response times by providing special removal equipment at high incident locations. Large equipment to be stored would include wreckers, sand trucks and other large vehicles. Smaller items would include cones, signs, flares, portable barriers, and other equipment for traffic control. Potential locations for these sites should be a topic addressed by the Incident Management Task Force.

Site Management Options

Procedures for **Properly Defined Traffic Control Techniques** and **Parking for Emergency Response** Vehicles have the potential to improve site operations by allowing better access to emergency vehicles. They should be reviewed by a subcommittee of the Incident Management Task Force.

Clearance Time Reduction Options

An optional recommendation of the Initial System plan is the construction of **Accident Investigation Sites** that allow vehicles to be removed from the travel lanes immediately. This is a low cost, high benefit solution which would significantly reduce clearance time on the freeway.

Traveler/Motorist Information Options

The Initial System will build upon the Early Action plan by adding additional **Variable Message** Signs at strategic locations within the system. Both permanent and portable VMS installations are anticipated at this stage of development.

The general strategy for locating Variable Message Signs is to place them ahead of decision points for drivers, a distance of about three fourths mile at ordinary freeway speeds. Mounting on existing bridge structures is accomplished wherever possible to minimize costs. Detailed field reviews are necessary to finalize locations due to different sign technologies, character height, and driver line-of-sight issues.

Highway Advisory Radio transmitters will be installed in Kentucky and Indiana as part of this system. Dual installation is necessary to provide the necessary coverage for the whole area. Both transmitters would be operated from the traffic operations center, and except in special localized circumstances, would provide the same message.

An optional component of the Initial System plan is the installation of Kiosks, for special traffic generators such as Standiford Field, Kentucky Fair and Exposition Center, Churchill Downs, and the downtown area. The kiosks would be used to inform motorists of traffic conditions along the freeway.

5.4 Full System Recommendations

The Full System plan includes coverage of approximately 14 miles of I-65 and 2.5 miles of I-264. It will serve the full I-65 corridor within the study area addressed in this report. The system will use an agency-owned fiber optic backbone communications system.

The Full System plan builds upon the Initial System by increasing system coverage, establishing instrumentation and full motion video for the entire corridor. Associated upgrades to computer systems and software are also anticipated as part of Full System development.

Although identified as a distinct implementation stage in this report, it is not likely that the Full System would be implemented in some future year as a single project. Rather, the system will probably be developed in a series of small steps over time. Experience with the Initial System and technology changes are likely to impact the timetable and character of future installations.

System coverage is also likely to be a greater issue before the Full System is totally implemented. With the Initial System in place and the traffic operations center operational, a determination may be made that the system should be extended to other freeway sections in the Metropolitan Louisville area. It is reasonable to defer this decision until the Initial System has been installed. Recommendations in this report are designed to provide flexibility for future expansion within or outside this study corridor.

Although it is essential to provide flexibility for future expansion, it is also important to identify a complete system at the outset so that interim stages of development are consistent with long-term needs and future options are not precluded. The Full System plan reflects each of these considerations.

Figure 5.3 shows the recommended system architecture for the Full System, while Figures 5.4a and 5.4b show the recommended layout. To expand and complement the actions and elements recommended for the Initial System Plan, the improvement items discussed in this section are recommended for inclusion in the Full System.

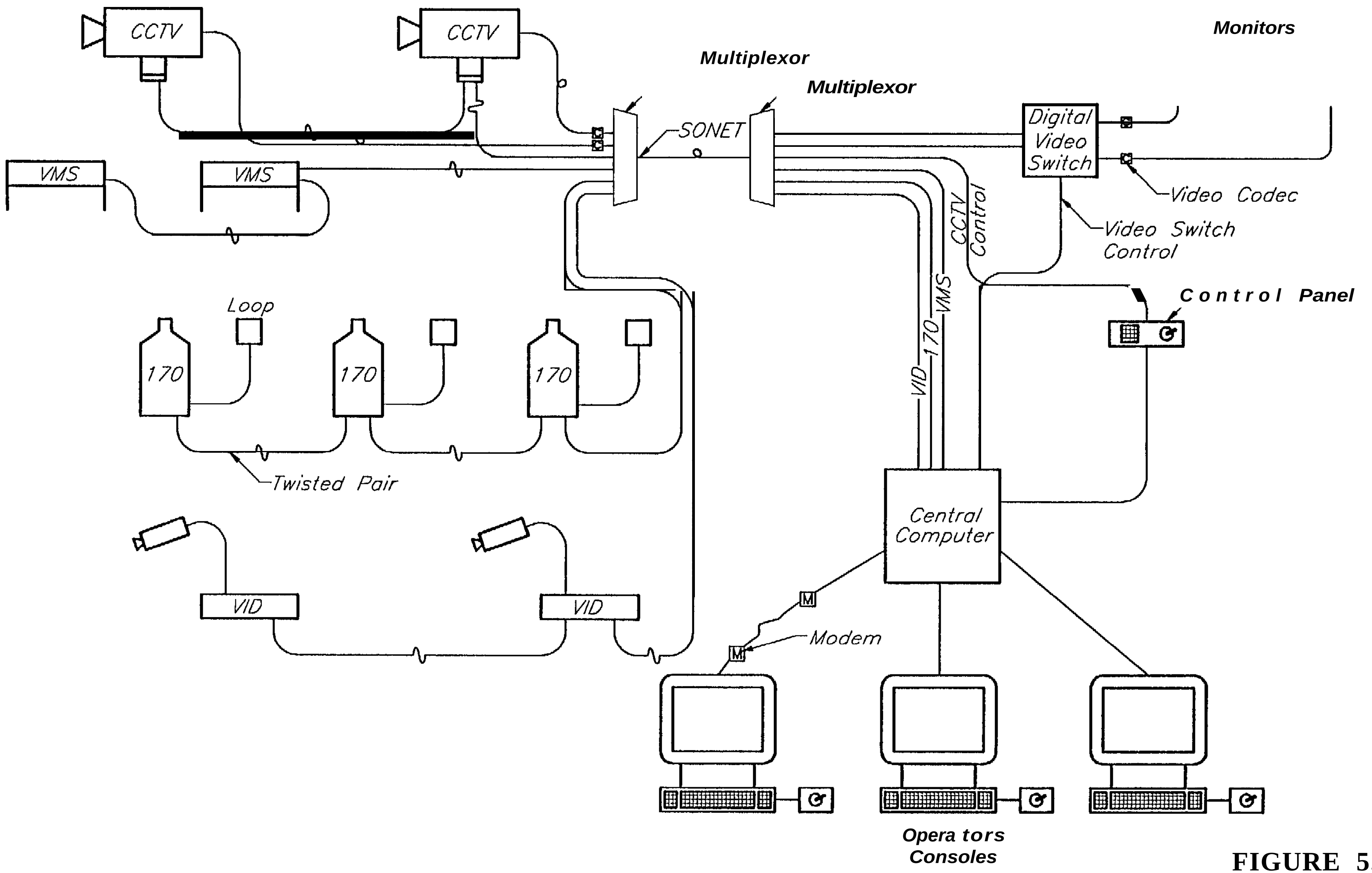
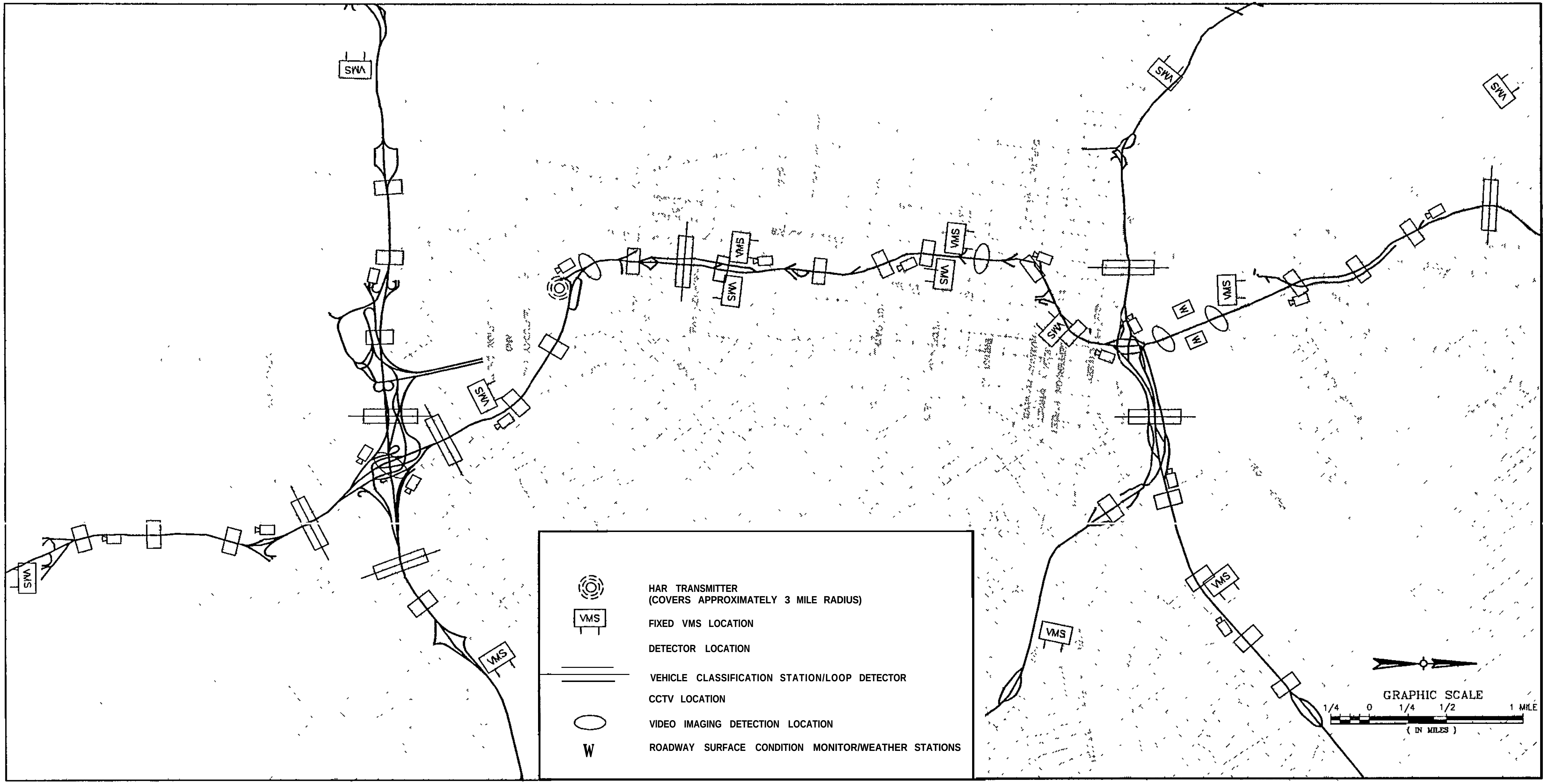


FIGURE 5.3

FULL SYSTEM ARCHITECTURE



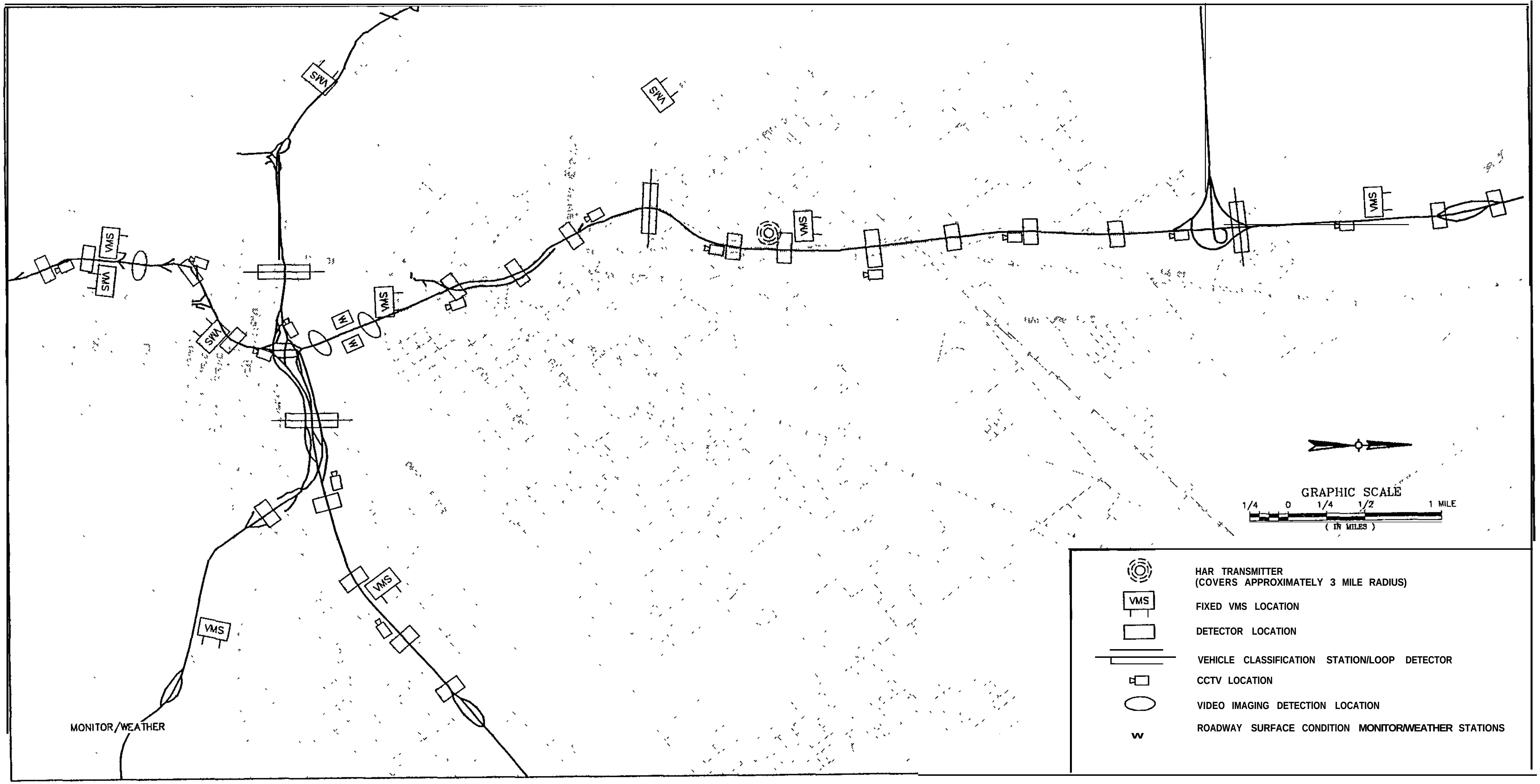
ADDITIONAL VMS LOCATIONS

I-71 WB, 3/4 mile east of I-264/I-71 interchange
I-64 WB. 3/4 mile east of I-264 interchange
I-264 WB(Inner Loop), 3/4 mile east of I-64 interchange

FIGURE 5.4a

FULL SYSTEM

HNTB in association with
PRESNELL ASSOCIATES INC.
I-65 Freeway Incident Management Study



ADDITIONAL VMS LOCATIONS

I-71 WB, 3/4 mile east of I-264/I-71 interchange
I-64 WB, 3/4 mile east of I-264 interchange
I-264 WB(Inner Loop), 3/4 mile east of I-64 interchange

FIGURE 5.4b

FULL SYSTEM

Incident Detection and Verification Options

The Full System for the Metropolitan Louisville area would include **Electronic Detection** and CCTV equipment directly linked to a regional **Traffic Operations Center.** The Initial System will cover only a portion of the Full System. The Full System will be fully instrumented and directly linked to the traffic operations center.

Operation of the Full System will require associated staff changes and expansion of the Traffic Operations Center. It will also involve computer hardware and software changes to accommodate the larger system. This study provides initial estimates of these changes, subject to future reviews based on actual operational experience.

All of the items mentioned under the Initial Plan should be continued as part of the overall system as they will fully support the technology to be included for detection and surveillance. Full coverage of the 16.5 miles of the freeway would require approximately 21 cameras, providing main line coverage at one-mile spacing and interchange coverage using multiple camera installations.

Motorist Aid Call Boxes/Telephones might be considered for installation at critical locations along the study area corridor. Although these devices are easily understood and accepted by the public, start up and operating costs are relatively high for hard-wired systems, installation may be limited by utilities (unless solar/cellular systems are used), and there is a high potential for vandalism. (Motorist aid call boxes were previously installed in the corridor, but were removed in 1977.)

Response Time Improvement Options

By the time of Full System development, the Traffic Operations Center and incident management team will have gained significant operational experience. The coordination benefits of the TOC and the cooperative approach of incident response agencies will be the most important elements of improved response time at this stage. No additional incident management system components are identified for the Full System.

Site Management Options

Site management issues should be reviewed as a part of after-action reviews of major incidents. Information gathered by the incident management system will assist in these reviews. No additional site management components are included in the Full System plan.

Traveler/Motorist Information Options

As part of the Full System, **PC/Modem** systems could be used to tap into the Traffic Operations Center's computer from homes or places of work. A telephone hotline could be established. Travelers would call in for conditions on I-65.

5.5 Capital, Operating, and Maintenance Costs

Capital cost estimates for the Initial System and the Full System are presented on Tables 5.3 and 5.4. These estimates have been developed from the equipment layouts discussed in previous sections and presented in Figures 5.1 through 5.4.

For the purposes of these capital estimates, the cost of shared items is allocated as two-thirds Kentucky responsibility and one-third Indiana responsibility. Software development will also be shared and agreements on licensing need to be prepared. Additionally, a cooperative agreement should be developed to allow the service patrol to cross the state line.

The estimated capital cost for the Initial System is $5.0 million. The coverage area will be approximately five miles of I-65 in Kentucky and two miles in Indiana. Tables 5.3a and 5.3b provide the details for this cost estimate and present a possible allocation of these costs to Kentucky and Indiana.

The installation of the Full System will be staged over time as an expansion of the Initial System. A well conceived system architecture and long-range design concept will permit the incremental growth of the system in a coordinated fashion. This coordinated growth can be accomplished so that each new piece of equipment will add to the total system function without requiring components to be discarded due to integration problems.

The estimated incremental capital cost of the Full System (beyond the Initial System) is approximately $8.5 million. Tables 5.4a and 5.4b provide the full system cost estimate details and present a possible allocation of these costs to Kentucky and Indiana.

The on-going operating and maintenance program for this systems is the key to success. In a recent U.S. General Accounting Office report, shortages of expertise, personnel, and funding were cited as reasons why many traffic control systems are not achieving their full potential. Since the Louisville system is being conceived of as an “operating” system, not just a “one-shot” construction project, establishing and maintaining adequate funding sources for operation and maintenance will be crucial to on-going success.

Reports from similar projects around the United States have shown operating and maintenance costs to be in the range of 8 percent to 12 percent of total system construction costs. A more detailed analysis of Personnel and Budget Resources is developed in Appendix C. The direction established for this analysis was to minimize these costs to define a lower threshold for them. The estimated annual operating budgets for the Initial System and the Full System are $359,000 and $614,500, respectively. Cooperative agreements in Kentucky and Indiana will be required to allocate these costs among the various government units.

Table 5.3a
Initial System Capital Cost Estimate - Kentucky

Approximately 5 miles of I-65

ITEM	QUANTITY	UNIT PRICE	AMOUNT
Variable Message Signs (fixed)	9	$150,000	$1,350,000
Variable Message Signs (portable)	4	$40,000	$160,000
Highway Advisory Radio Transmitter	1	$35,000	$35,000
Highway Advisory Radio Signs (pair)	2	$30,000	$60,000
Closed Circuit Television (CCTV)	6	$25,000	$150,000
Video Transmission (wireless)	6	$50,000	$300,000
CCTV Control System (Kentucky's share) (1)			$10,000
Loop Detectors/Controller	8	$25,000	$200,000
Vehicle Classification Stations (additional cost)	1	$5,000	$5,000
Video Imaging Detection Systems (VIDS)	4	$40,000	$160,000
Weather Stations			
Field monitoring station with surface and atmospheric detectors	1	$28,000	$28,000
Central hardware/software	1	$30,000	$30,000
Incident Response Vehicle (2)	1	Shared	$100,000
Static Signs/Milepost Markers		Shared	$20,000
Traffic Operations Center (Kentucky's share) (1)		Shared	$33,000
Computer Equipment (Kentucky's share) (1)		Shared	$33,000
Software Development		Shared	$167,000
Subtotal			$2,841,000
Engineering/Systems Integration 15 %			$426,200
Contingency 15 %			$426,200
TOTAL Kentucky)			$3,693,400
GRAND TOTAL (Kentucky & Indiana)			$5,028,600

(1) - Co-location in existing building in Louisville, site to be determined
(2) - Assumed cooperative agreement will be developed to allow vehicle to cross state line

Table 5.3b
Initial System Capital Cost Estimate - Indiana

Approximately 2 miles of I-65

ITEM	QUANTITY	UNIT PRICE	AMOUNT
Variable Message Signs (fixed)	4	$150,000	$600,000
Highway Advisory Radio Transmitter	1	$35,000	$35,000
Highway Advisory Radio Signs (pair)	2	$30,000	$60,000
Closed Circuit Television (CCTV)	2	$25,000	$50,000
Video Transmission (wireless)	2	$50,000	$100,000
CCTV Control System (Indiana's share) (1)		Shared	$5,000
Incident Response Vehicle (2)		Shared	$50,000
Static Signs/Milepost Markers		Shared	$10,000
Traffic Operations Center (Indiana's share) (1)		Shared	$17,000
Computer Equipment (Indiana's share) (1)		Shared	$17,000
Software Development		Shared	$83,000
Subtotal			$1,027,000
Engineering/Systems Integration 15 %			$154,100
Contingency 15 %			$154,100
TOTAL (Indiana)			$1,335,200
GRAND TOTAL (Kentucky & Indiana)			$5,028,600

(1) - Co-location in existing building in Louisville, site to be determined
(2) - Assumed cooperative agreement will be developed to allow vehicle to cross state line

Table 5.4a
Full System Capital Cost Estimate - Kentucky

Approximately 7.6 miles of I-65 and approximately 2.4 miles of I-264

ITEM	QUANTITY	UNIT PRICE	AMOUNT
Variable Message Signs (fixed)	15	$150,000	$2,250,000
Variable Message Signs (portable)	4	$40,000	$160,000
Highway Advisory Radio Transmitter	1	$35,000	$35,000
Highway Advisory Radio Signs (pair)	2	$30,000	$60,000
Closed Circuit Television (CCTV)	14	$25,000	$350,000
CCTV Switch, Control Equipment (Kentucky's share) (1)			$67,000
Conduit/Cable (LF)	52,800	$40	$2,122,000
Communications Equipment (3)	2	$100,000	$200,000
Loop Detectors/Controller	28	$25,000	$700,000
Vehicle Classification Stations (additional cost)	7	$5,000	$35,000
Video Imaging Detection Systems	5	$40,000	$200,000
Weather Stations			
Field monitoring station with surface and atmospheric detectors	1	$28,000	$28,000
Central hardware/software	1	$30,000	$30,000
Incident Response Vehicle (2)		Shared	$100,000
Static Signs/Milepost Markers		Shared	$20,000
Traffic Operations Center (Kentucky's share) (1)		Shared	$320,000
Computer Equipment (Kentucky's share) (1)		Shared	$67,000
Software Development		Shared	$500,000
Subtotal			$7,234,000
Engineering/Systems Integration 15 %			$1,085,100
Contingency 15 %			$1,085,100
TOTAL (Kentucky)			$9,404,200
GRAND TOTAL (Kentucky & Indiana)			$13,517,200

(1) - Co-location in existing building in Louisville, site to be determined
(2) - Assumed cooperative agreement will be developed to allow vehicle to cross state line
(3) - Assumed located within existing owned facility

Table 5.4b
Full System Capital Cost Estimate - Indiana

Approximately 6.5 miles of I-65 from the Ohio River to SR 60

ITEM	QUANTITY	UNIT PRICE	AMOUNT
Variable Message Signs (fixed)	4	$150,000	$600,000
Highway Advisory Radio Transmitter	1	$35,000	$35,000
Highway Advisory Radio Signs (pair)	2	$30,000	$60,000
Closed Circuit Television (CCTV)	7	$25,000	$175,000
CCTV Switch, Control Equipment (Indiana's Share) (1)			$33,000
Conduit/Cable (LF)	34,320	$40	$1,372,800
Communications Equipment (3)	1	$100,000	$100,000
Loop Detectors/Controllers	11	$25,000	$275,000
Vehicle Classification Stations (additional cost)	2	$5,000	$10,000
Incident Response Vehicle (2)		Shared	$50,000
Static Signs/Milepost Markers		Shared	$10,000
Operations Center (Indiana's share) (1)		Shared	$160,000
Computer Equipment (Indiana's share) (1)		Shared	$33,000
Software Development		Shared	$250,000
Subtotal			$3,163,800
Engineering/Systems Integration 15 %			$474,600
Contingency 15 %			$474,600
TOTAL (Indiana)			$4,113,000
GRAND TOTAL (Kentucky & Indiana)			$13,517,200

(1) - Co-location in existing building in Louisville, site to be determined
(2) - Assumed cooperative agreement will be developed to allow vehicle to cross state line
(3) - Assumed located within existing owned facility

5.6 Traffic Operations Center Location

Although a specific site for the Traffic Operations Center need not be designated at this stage of development, it is useful to review and narrow a list of sites to guide further design and to provide for potential opportunities that may arise prior to final system design.

Access to the Traffic Operations Center information will be a significant consideration in developing the system architecture for the system. Multiple access points will be provided at remote locations so that agency personnel can access data and respond appropriately to incidents. These issues are not critical with respect to the location of the Traffic Operations Center, but they will need to be addressed as a part of system design.

It is assumed that one Traffic Operations Center will be developed for the Metropolitan Louisville area. This does not preclude remote data hook-ups for reference and use outside the control center. It is probable that such a hook-up will be provided at a minimum of one location in Indiana, probably at the Indiana State Police Headquarters in Sellersburg.

Thirteen potential locations for the Traffic Operations Center were identified by and reviewed with the Incident Management Task Force. Based on this input, the list was narrowed to four finalists:

- Louisville City Hall, 601 West Jefferson Street
- Old Ballet/Telephone Switching Facility, Bardstown Road and Rosewood Avenue
- South Central Bell Facility, Poplar Level Road at Clarks Lane
- Louisville Emergency Medical Services Building, 1805 South Brook Street

These locations are shown on Figure 5.5. Each site provides advantages and disadvantages with respect to the intended use of the center, as indicated on Table 5.5.

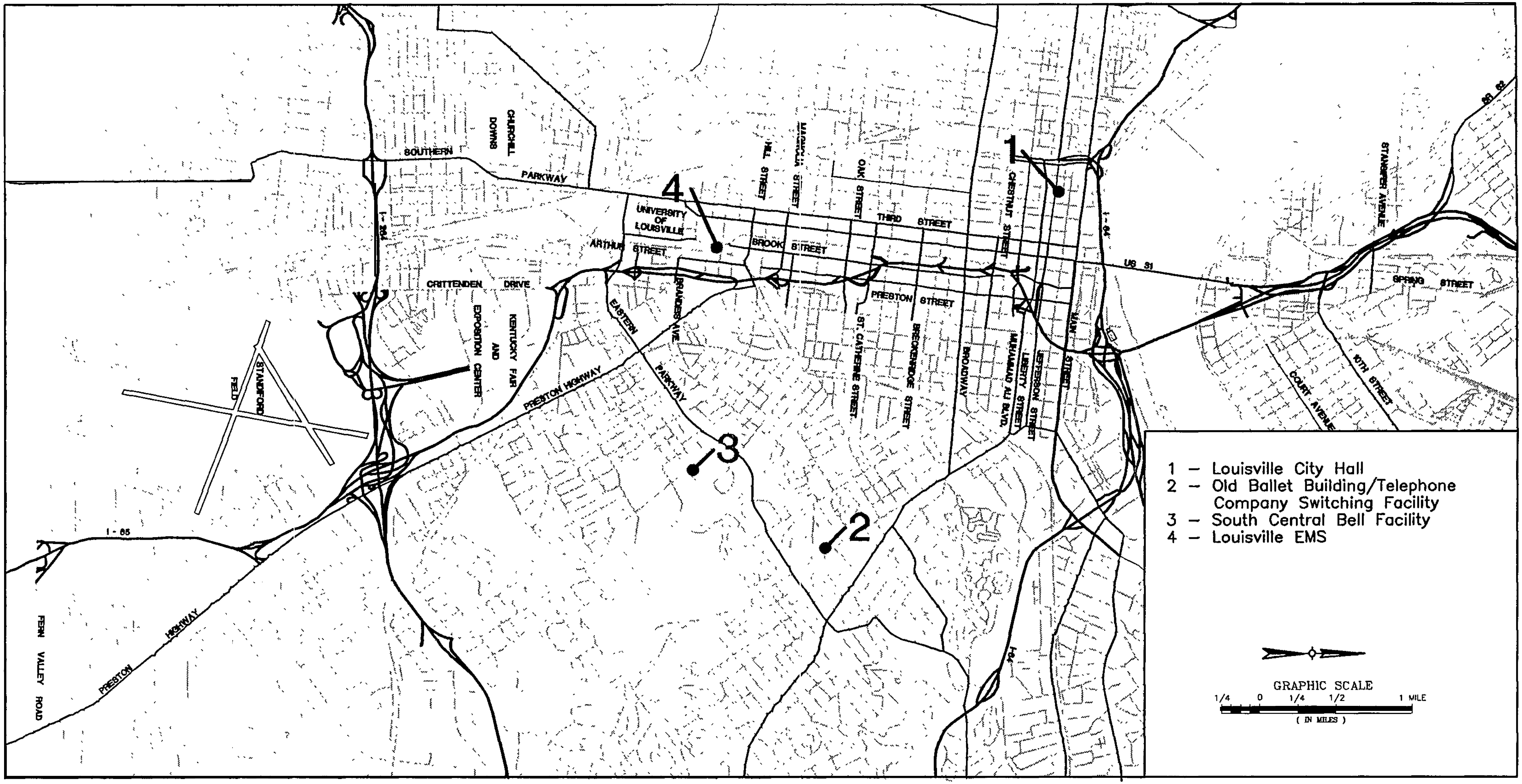


FIGURE 5.5

POTENTIAL TRAFFIC OPERATION CENTER SITES

SOURCE:
-HNTB, 1994

HNTB in association with
PRESNELL ASSOCIATES INC.
I-65 Freeway Incident Management Study

Table 5.5
Potential Traffic Operations Center Locations

Site Name & Location	Distance from I-65	Owner's Name	Curreut or Future occupants	Space Available	Contact Person	Comments
1. City Hall, 601 W. Jefferson Street	0.9 mi.	City of Louisville	Public Works, DES, Mayor's Office, (Louisville Police),(County Judge)	150 SF (for TOC)	Mr. Jack Nevin 574-3900	- Probable location of the City's traffic control center - Small amount of space
2. Old Ballet Building/Telephone Company Switching Facility, Bardstown Road & Rosewood Avenue	2.3 mi.	City of Louisville	DES, EMS	9,000 SF	Mr. Doug Hamilton 574-2445	• Occupancy within a year • Hub for microwave and communications • Technical expertise on site (radio technicians) - Poor parking - May be able to deck second floor for additional space
3. South Central Bell Facility, Poplar Level Road Garage at Clarks Lane	I .8 mi.	City of Louisville	DES, EMS	6,000 SF	Mr. Dick Bartlett 636-3530	• May be able to place tower there . State owns adjacent land • 3,000 S.F. garage may be decked for second story • City getting purchase option • Space available depends on whether the police move there • Lots of offices and conference rooms
4. Louisville Emergency Medical Services, 1805 South Brook Street	0.2 mi.	City of Louisville	EMS	12,000 SF	Mr. Dick Bartlett 636-3530	• Depends on proposed merger between EMS and fire department • If merge garage space will be available for conversion

DES = Louisville and Jefferson County Disaster and Emergency Services
EMS = Louisville Emergency Medical Services

5.7 Traffic Operations Center Layout

Three generic conceptual plans for a Traffic Operations Center are presented on Figures 5.6, 5.7, and 5.8. The three plans range in total area from 4,400 SF to 10,000 SF. These layouts assume that the traffic operations center is co-located with other functions in a single facility. Functions that are assumed to be located elsewhere in the facility include:

- Emergency generator, load bank, and fuel tank
- Transformers, main building electrical room
- Building HVAC equipment
- Condenser, radiator or chiller for computer/communications room air handling units
- Restrooms
- Employee lounge or lunchroom
- Main reception area
- Multi-purpose space
- Conference room and clerical support (except in 10,000 SF scheme)

The 4,400 SF scheme (Figure 5.6) has space allocations below the minimum range of estimated space needs. Its control room has positions for four traffic controllers. This layout assumes that air distribution and cable routing are accommodated without raised access flooring. The open office cubicles in the staff area are sized at 7.5 feet by 7.5 feet. No provision is made for as yet undefined items such as file cabinets, book cases, printers, plotters, copiers or fax machines.

The 7,000 SF scheme (Figure 5.7) has areas generally within the range of expected space needs. Its control room has space for up to five or six traffic operations and/or communications positions. No provision is made for rear projection video although with emerging flat display technology, this may not be an issue. The viewing, operations and electronics areas are on raised access floor. The staff area has space for 12 people in open office cubicles plus a shared equipment or drafting station. Lateral files or bookcases line the circulation spine. A small copy/supply room is shown, but may not be needed depending on proximity of similar functions elsewhere in the facility. This scheme is laid out with a general building circulation corridor bisecting the TOC.

The 10,000 SF scheme (Figure 5.8) approximates an upper range of potential space needs. It illustrates a control room subdivided into operations and communications. Space is provided for up to six traffic operations positions and two communications positions. Room for one large screen, rear projection video display is included. The control room and electronics room are on raised access floor for cooled air supply and cable distribution. Offices and staff areas are laid out for up to 25 percent growth; ie. one additional office and three additional staff cubicles.

All of these schemes are generic in nature. No provisions have been made for accommodating specific facility requirements such as configuration of space available, building circulation patterns and exiting requirements, exterior windows, views, and glare, adjacencies of other building functions, or building structural, mechanical and electrical systems.

Figure 5.6
Conceptual Plan
4,400 Square Feet Traffic Operations Center

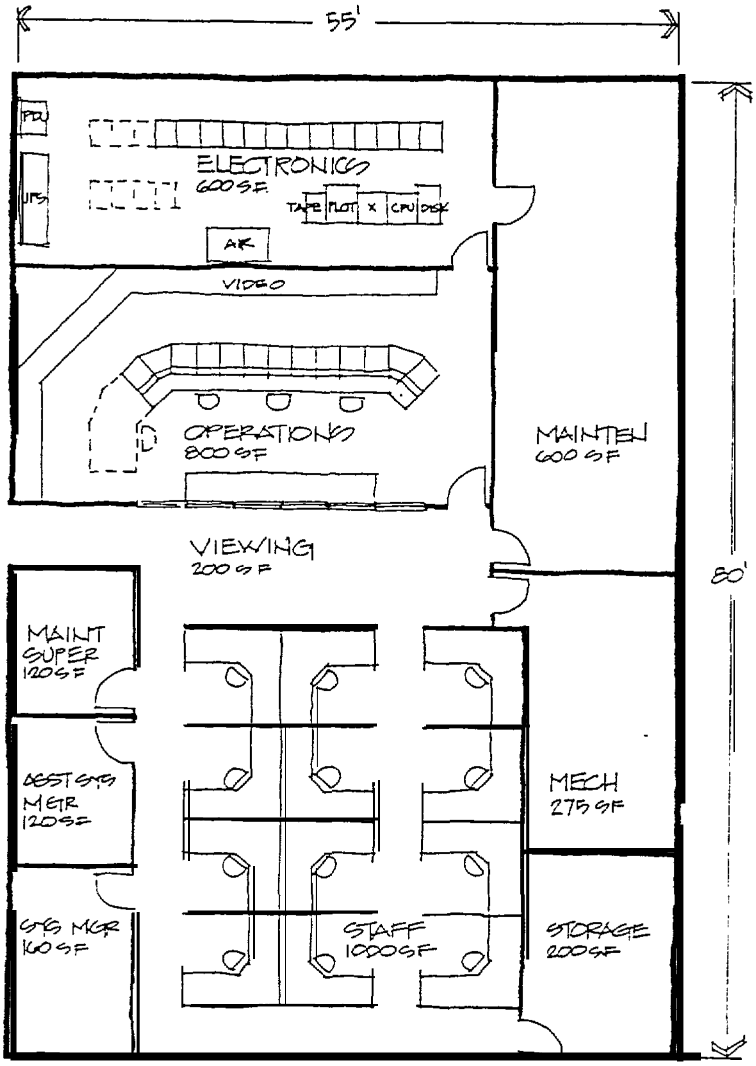


Figure 5.7
Conceptual Plan
7,000 Square Feet Traffic Operations Center

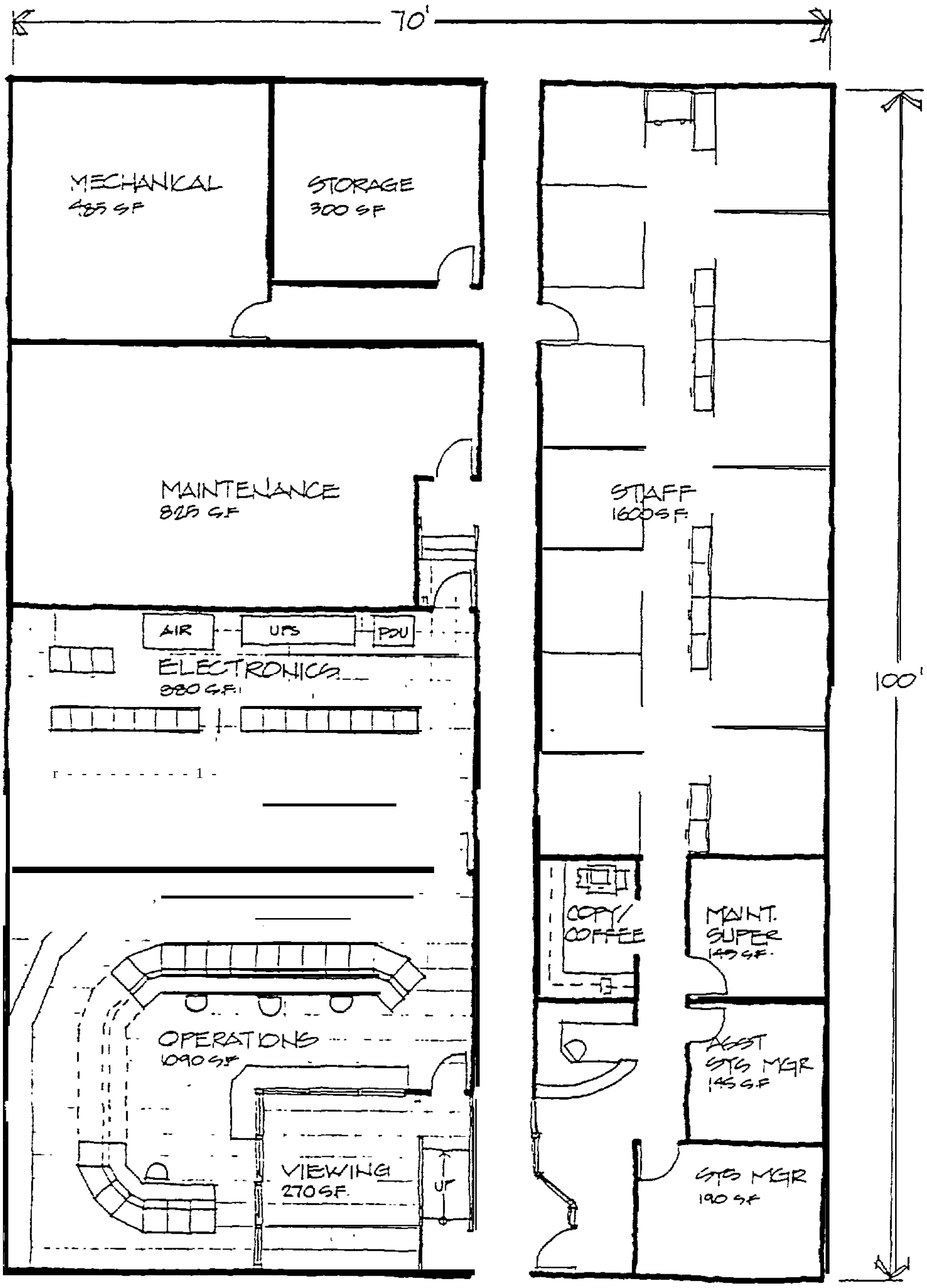
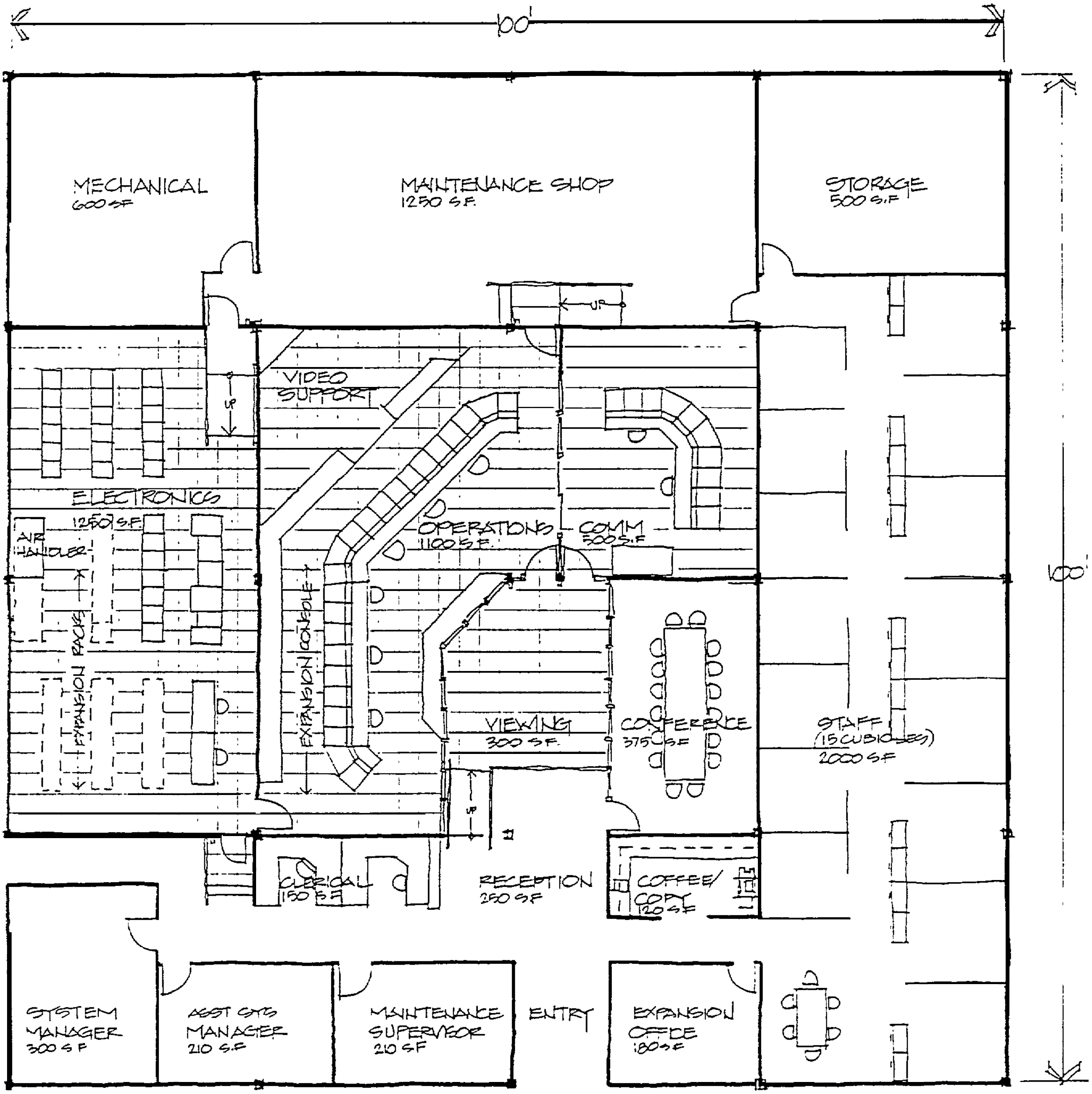


Figure 5.8
Conceptual Plan
10,000 Square Feet Traffic Operations Center



5.8 Benefit/Cost Analysis

The Initial System is intended to provide incident management on the high volume, high incident section of I-65. The benefits of the Initial System have been calculated based upon a comparison of the annual vehicle hours of delay experienced under a baseline condition to the annual vehicle hours of delay with the implementation of the Initial System.

Incident data was provided for the calendar years of 1992 and 1993 by the Louisville Division of Police. There were an estimated 8,050 reported incidents along I-65 within the city limits of Louisville. Approximately 80 percent of these, or 6,440 incidents, were related to the section between Crittenden Drive and the Kennedy Interchange. During the year 1993, there were approximately 630 accidents along the same limits of I-65. The ratio of incidents to accidents was approximately 10 to 1. In Indiana, there were 81 accidents between the Kennedy Bridge and SR 62 in 1993. This translates to approximately 810 incidents per year based upon the incident to accident ratio for Louisville.

The Initial System was divided into seven one-mile segments with a unique capacity and demand during the AM, Midday, and PM periods. The method used for calculating delay caused by an incident is described in "Analytical Procedures for Estimating Freeway Traffic Congestion" by Juan Morales in Public Roads, Volume 50, No. 2, 1986. Baseline incident conditions assume a reduction in capacity of 50 percent (representing a typical single lane blockage) and an incident duration of 30 minutes. Under the baseline conditions, traffic flow demand is assumed to remain constant for each of the seven segments. Once the vehicle hours of delay per incident per segment were calculated, that figure was multiplied by the number of annual incidents on each segment to determine the baseline annual vehicle hours of delay.

Based on a sample of incident data provided for Louisville, approximately 18 percent of the total incidents (including accidents) occurred during the AM peak period from 7:00 AM to 9:00 AM, 17 percent in the PM peak period from 4:00 PM to 6:00 PM, 40 percent occurred between the hours of 9:00 AM and 4:00 PM, and 25 percent of the total incidents on an average day occurred between 6:00 PM and 7:00 AM. Approximately 86 percent of the total incidents occurred on a weekday (Monday through Friday).

An incident duration reduction of 5 minutes was used to represent Initial System conditions. The resultant annual vehicle hours of delay was compared to baseline conditions. The difference between the two values was the savings in vehicle-hours of delay. A value of time of $7.50 per vehicle hour of delay was applied to the 11 hour period from 7:00 AM to 6:00 PM to determine the annual benefits of implementing the Initial System. In addition, a cost of $1 per vehicle hour of delay was used to estimated fuel consumption savings. A 10 percent reduction in accidents was also assumed, with a benefit of $8,000 per accident.

Based upon the reduced delay and accidents, the annual benefit is approximately $7.1 million per year. The delay experienced under the Initial System during the evening and overnight hours is expected to be negligible because sufficient capacity remains with one lane blocked to accommodate the volumes during these time periods.

The Initial System has a total cost of $5 million. The future annual cost of designing and constructing the Initial System, which is based upon a lo-year life and an inflation rate of six percent, has been calculated to be approximately $1.19 million per year. This $1.19 million includes the operation and maintenance costs of approximately $500,000 per year. Thus, the benefit to cost ratio of the Initial System from Crittenden Drive to SR 62 on an annual basis is approximately 6 to 1.

It is important to note that many benefits of the system are not reflected in the benefit/cost analysis since they are not readily quantifiable. Clearly, reductions in injuries and elimination of fatalities fall within this category. Other benefits are social or economic, and many involve major traffic generators in the Metropolitan Louisville area.

For the Kentucky Fair and Exposition Center, most benefits of a freeway incident management system will result from improved freeway flow in the Metropolitan Louisville area. Given the volumes of traffic served, surveillance should ultimately be provided near freeway access routes, and provision should be made for direct communication with the Freeway Management Center. Motorists would benefit by improved information and guidance from variable message signs.

Availability of a freeway incident management system is not likely to prompt changes to plans currently used for major Churchill Downs events. A traffic operations center and its freeway monitoring equipment will supplement existing plans by providing the opportunity to monitor traffic flows while they occur, and by improving communications to motorists.

For each of the major traffic generators near I-65 and Watterson Expressway, the most important role of the system will be its primary functions of identifying and clearing incidents on the freeway system, and improving communications. The benefits will be significant, given the magnitude of traffic generated and the prevalence of motorists unfamiliar with the area.

5.9 Air Quality Issues

The Metropolitan Louisville area is currently classified by the Environmental Protection Agency as moderate non-attainment for the pollutant ozone (0,). Not emitted directly from tailpipes, ozone is formed when precursor emissions, hydrocarbons (HC) and nitrogen oxides (NO_x), react in the presence of sunlight. Carbon monoxide (CO) is also of concern, since vehicles produce up to 90 percent of CO emissions in urban areas.

On July 15, 1994, KIPDA submitted a revised air quality conformity analysis for the FY 1995-FY 1998 Transportation Improvement Program (TIP) to Federal, state, and local review agencies. The purpose of this analysis was to determine if the TIP is in conformance with the State Implementation Plans (SIPs) of Kentucky and Indiana. Ideally, programmed transportation projects should not increase emission levels on an areawide basis. The results show that for each of the analysis years, emissions of both HC and NO, for the action scenario are less than for the baseline scenario. In other words, emissions would be reduced on an areawide basis by implementing the TIP projects. Thus, the TIP will be in conformance, provided that the Transportation Control Measures (TCMs) contained in the SIP are implemented by 1996.

Analysis

To estimate the emissions reduction potential of the Initial incident management system, three approaches were considered: Travel Demand Model, Traffic Simulation Model, and Speed-Volume Computation. The Travel Demand Model approach is used by KIPDA for the conformity analysis, but would not be adequate for modeling improvements within individual corridors. In addition, areawide travel demand models such as KIPDA's MINUTP are not sensitive to traffic operations improvements. The Traffic Simulation Model approach would provide greater accuracy and confidence in the results, but at a much greater cost. Discussions with representatives of FHWA, KyTC, and KIPDA yielded a consensus that, for the purposes of this study, the Speed-Volume Computation provided an adequate level of detail and accuracy. More detailed air quality analysis using a traffic simulation model such as FREQ or FRESIM will be performed during the final design phase.

The following list summarizes the sources for the various data used for the air quality analysis.

Pollutants:	CO, HC, and NO,	
Analysis Year:	1996	
Facility:	I-65 from Crittenden Drive to SR 62	
Direction:	Northbound and Southbound (separately)	
Distances:	Collected by HNTB field crew; city maps	
Volumes:	KY - Collected by HNTB - 1993; IN - Collected by IN-DOT - 1992; Per KIPDA, volumes grown at 2% annually to analysis year	
speeds:	Capacity analysis and travel time runs performed by HNTB	
Speed Increases:	Off-peak periods, 0 % , due to adequate capacity Assume maximum speed = 55 mph	
	Scenario A:	Peak periods, + 2.5%, per CALTRANS Urban Gridlock study
	Scenario B:	Peak periods, + 5.0%
Emission Factors:	Provided by Jefferson County Air Pollution Control District for Jefferson County and Clark County (separately)	
Daily Equivalents:	5 days per week X 52 weeks + 1 day = 261 day equivalents	

A separate Air Quality Report has been prepared which contains the emission factors data as well as the spreadsheets used for the analysis. The analysis yielded reductions in both HC and CO emissions, while NO, emissions increased slightly.

Discussion

The Congestion Mitigation and Air Quality Improvement (CMAQ) Program was established by the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA). Its purpose is to help states implement their transportation/air quality programs and attain the national standards for carbon monoxide and ozone. FHWA's 1994 publication A Guide to the Congestion Mitigation and Air Quality Improvement Program provides examples of some typical traffic flow improvement projects which may be funded.

> "Eligible highway/road projects include those which improve air quality by reducing congestion without adding lane mileage. These projects can be particularly effective at reducing CO "hot spots," which are often caused by idling vehicles at congested bottlenecks. Eligible projects include signalization to improve traffic flow; trafffic management/control, *such as incident management* and ramp metering; and improvements of intersections, such as the addition of turn lanes. The construction or dedication of high occupancy vehicle (HOV) lanes is also an eligible project."

The Commonwealth of Kentucky distributes CMAQ funds among the multiple nonattainment areas. The money must be spent on projects which reduce ozone precursors and CO from transportation sources. The federal share for most eligible CMAQ projects is 90 percent, if used on the Interstate System. Thus, the I-65 Freeway Incident Management System could be federally funded to this level.

The FY 1992 Annual CMAQ Report, prepared jointly by FHWA and FTA, reviewed the activities funded under the first year of the program. The report notes the following:

> "The emission reduction potential of traffic flow improvements is comparable to other TCMs and can be realized more quickly, making them an effective strategy for meeting short term goals and deadlines.

In addition, the FY 1992 Annual CMAQ Report made the following observation on the emissions reductions documented by other agencies during the first year of the CMAQ program:

> "The benefits are very small, on the order of 1 to 1000 kilograms per day, with few exceptions. Most were under 100 kilograms per day."

The use of traffic enforcement and management programs as a supply management transportation control measure (TCM) is widespread. In 1993, the U.S. Government Accounting Office issued the report Urban Transnortation: Reducing Vehicle Emissions with Transnortation Control Measures. To better understand opinions regarding the relative effectiveness of various TCM strategies, 119 Metropolitan Planning Organizations (MPOs) in ozone and carbon monoxide nonattainment areas were surveyed. One question dealt with the degree that various TCMs have the potential to reduce automobile emissions that contribute to ambient ozone. Nearly 70 percent responded that highway surveillance and control systems as well as incident management and motorist aid programs contribute to some extent. Eighty-three percent of the ozone nonattainment MPOs expressing an opinion said that TCMs could reduce emissions by 0 to 3 percent. A 1992 FHWA report, cited in the GAO report, concluded that typical TCMs would rarely yield more than a 5-percent reduction in emissions and in most cases would not yield more than a 2-percent reduction.

On March 10, 1994, FHWA disseminated a memorandum to the 10 FHWA regions addressing conformity and NO,. It was prepared in response to the difficulties faced by nonattainment areas across the country in achieving conformity determinations for their improvement programs. Several key points were noted in the attachments:

- NO, emissions increase with increasing average speed above 20 mph

- Transportation options such as speed limit enforcement can reduce NO, emissions

- NO, waivers can be granted by EPA which would eliminate the need for performing tests

Although modest from an areawide standpoint, the emissions reductions represent a positive step toward improving the environment through more efficient utilization of existing transportation facilities. These air quality policy issues will continue to evolve and should be tracked as the project progresses. Also, as stated previously, more detailed air quality analysis using a traffic simulation model will be performed during the final design phase.